STRATHFIELD COUNCIL

Stormwater Management Code

In force from 26 October 1994

Stormwater Management Policy

POLICY NAME	Strathfield Council Stormwater Management Policy
DATE ADOPTED	18 October 1994
REF	417/99
RELATED POLICIES/DOCUMENTS	Strathfield Council Stormwater Management Code

1.0 Introduction

1.1 Title and Commencement

This policy is titled *Strathfield Council Stormwater Management Policy.* This policy was adopted on 18 October 1994 by Council resolution and made operational on 26 October 1994.

1.2 Objectives of the Policy

The objectives of the policy is:

- To preserve and protect the amenity and property of residents, property owners and the community.
- To ensure the safety of residents and the community.
- To meet reasonable expectations and statutory requirements for the development of properties.
- To protect the physical environment and receiving waters of catchments.

2.0 Policy Statement

All developments / building work within the Strathfield Council area shall incorporate stormwater drainage facilities to collect and convey stormwater runoff to Council's system, ensuring adverse impact on the surrounding environment is avoided.

3.0 Administration

All development / building activities within the area of Strathfield Council affecting stormwater runoff will be regulated to achieve the objectives.

Development / building submissions and activities will need to be in accordance with the procedures and requirements contained in Council's "Stormwater Management Code" to comply with this policy.

This policy and the Code will be administered by Council's Director Operations, and will be reviewed regularly and revised as appropriate.

The "Stormwater Management Code" is published to enable anyone undertaking development building activities within the Strathfield Council area to prepare and design their projects to comply with the policy.

CONTENTS

1 PURPOSE

As a consent authority, Council requires all developers to demonstrate that any development / building work proposed will comply with all relevant codes, standards and policies.

This Code is intended to provide a clear statement of policy, requirements and methods relating to stormwater drainage for residential, commercial, industrial and all other types of development building work. The Code will assist in the submission of the necessary information required to expedite Council approvals.

Technical information is provided only in the supplements. Designs are to be prepared by suitably qualified and experienced designers.

The Code should be read by all applicants for development / building works prior to lodging applications for Council approval.

2 COMMENTARY

2.1 Document Structure

The document is separated into the following sections:

Section 3	Scope and Application – Details when and where the Code is to apply.
Section 4	Planning Issues – Discussion issues that should be considered and dealt with at the time the development is being planned and feasibility determined.
Section 5	Design Requirements – Outlines details required and to be considered in the design of the development.
Section 6	Construction – Describes the way construction activities relating to the development, are undertaken.
Section 7	Documentation Required – Lists the documentation and details necessary for Council to approve applications and for there to be a demonstration of compliance with the policy.
Section 8	Other Parties – Provides information on the requirements of other parties affected by developments that need to be satisfied.
Section 9	Information Available From Council – An indication of where Council can assist applicants in the process.
Section 10, 11	Glossary References – Explanation of terms used and details of sources referred to within the document or of assistance in complying with the guideline requirements.
Section 12	Supplement – Specific information for design purposes.

2.2 General

The cost of all survey, design construction works, restoration, utility adjustments, easement acquisition and legal costs involved in the development / building works are to be borne by the developer.

The responsibility for the submission of satisfactory details as required by this Code and any consent conditions, rests with the applicant.

Council's corporate strategy aims to:

- Eliminate surface runoff from the drainage system through private property to a 1 in 20 hear Average recurrence Interval (ARI) standard.

- Effectively and safely manage surface runoff to a 1 in 100 year ARI standard.

The standards referred to in this document incorporate this strategy.

3 SCOPE AND APPLICATION

This Code applies to all developments / building works requiring Council consent within the Strathfield Council area, and will be administered by Council's Director Operations (changed from Engineering) as appropriate.

Development / building activities that are covered by the Code are those requiring written consent from Council. This covers:

Residential

Single dwelling	- New (including replacement)
Single dwelling	- Extensions, garages carports etc
Dual Occupancy	-
Medium Density	- Villa, Townhouse etc
High Density	- Units, Apartments etc
Tennis Courts	

Commercial
Industrial
Institutional Buildings - Schools, Hospitals
Paving Driveways and Roadworks
Subdivisions
Drainage works

- In public lands
- piping or lining of open watercourses
- modifications to existing systems excluding roofwater lines

All other developments

4 PLANNING ISSUES

4.1 Adverse Impact and Controlling Site Runoff

Development / building work must not cause an adverse impact on adjoining or any other properties. This includes preserving surface flow paths and not increasing water levels. Site discharges will need to be restricted to pre- development discharges using On-site Stormwater Detention (OSD) storages where required. Protection is to be provided for all rainfall events through to 100 years ARI.

4.2 On-site Stormwater Detention (OSD) Storage

OSD is required to limit discharges from specified developments / building works to pre-development conditions. Council's OSD requirements have been formulated to ensure there is no increase in discharges adjacent to the site or elsewhere in the catchment for all rainfall events through to 100 years ARI.

Other than for single residential dwelling projects OSD will be required for all developments / building works where the proposed increased paved and/or roofed areas exceed 100m².

OSD will only be required for single residential dwelling works where the cumulative site imperviousness (existing and new roof and paved areas) exceeds 65% of the site area and where the proposed work exceeds 40m² in area. OSD may also be required for single residential dwelling works where gravity fall to the street frontage cannot be achieved (see 4.5). Where OSD is required for single residential dwelling projects the OSD system is to be designed to collect and control flows from all roof and paved areas, new and existing.

Where OSD systems are required these systems will require full hydraulic design in accordance with the details in Supplement 2.

Where a Development Application is required, the Development Application is to include a Stormwater Drainage Concept Plan (SDCP – see 4.7) which will outline the OSD proposed. A detailed design will be required at the Building Application stage.

Where separate titles can or will be created (by subdivision) with the development, separate OSD storages are generally to be provided. Storages can be amalgamated or omitted for some lots providing the storage proposed for the overall development can meet the permitted site discharge and storage requirements in accordance with Supplement 2.

Storages outflows are to be controlled to ensure the full range of ARI protection occurs. This will require the OSD to incorporate a range of storage-discharge values for various ARI's.

OSD storages should be located as close as possible to the lowest point of the site, with paved areas, and pipes to drain to it. Storages are encouraged to be above ground and incorporated into driveway / parking areas. Storages in landscaping areas will require extra volume to compensate for vegetation growth (see 5.5).
Storages must not be located in overland flow paths which convey catchment flows through the site. Storages are to be in common areas (rather than privately controlled areas such as courtyards) for developments with multiple dwellings or units.

Discharge restriction from OSD systems shall be by the use of appropriately sized short length of reduced diameter pipe and weir; orifice plates shall not be used.

Council will maintain a register of on-site detention systems and Council officers will inspect these systems on an annual basis to ensure such systems are maintained and are fully operated.

4.3 Surface Flow Paths

Surface flow paths are an integral part of the drainage system. They are to be preserved, or alternatives provided, wherever they pass through or affect the development / building site. Site discharges are not to be concentrated to a degree greater than that which naturally occurs. Redirection of flows including to other sub catchments is not permitted unless appropriate counter measures are undertaken. Flows to the receiving system or sub-catchment are not to be increased. Flow paths are to be retained within easements wherever possible.

4.4 Floor and Ground Levels

Building floor levels need to be set above surrounding ground levels with an adequate freeboard to surface runoff flows or ponding levels (see 5.3). Where recontouring of the site is proposed, the existing ground levels at the boundaries are to be retained with a maximum 1 in 4 finished ground level slopes. Retaining walls are not to be constructed closer than 0.9m to the boundary unless approval is obtained. Existing ground surface levels are to be retained unless approval is obtained to vary these levels.

Where it is proposed to recontour the site to facilitate gravity drainage, only minor variation in surface levels will be considered and such will necessitate referral to Council for approval.

4.5 Gravity Drainage

All stormwater drainage connecting to Council's drainage system is to be by gravity means. Mechanical means (ie pumps) for disposal of stormwater runoff will not be permitted. Subsoil and basement drainage systems where separate from the stormwater drainage may be exempted from this requirement.

The acquisition of an easement over any intervening downstream properties (at the developers cost) will normally be required for sites that do not drain to:

- The street
- Council land containing a drainage line, or
- An existing Council pipeline within the development site.

Without a gravity stormwater drainage system being provided, development consent will not be granted. Written consent for the piping and acquisition of an easement is to be obtained from adjoining owners and provided to Council with the development application.

Exception to gravity disposal may be given at the discretion of Council's Director Operations for sites that do not drain to the street, only for single residential dwelling construction where genuine attempts at acquiring a downstream easement have failed. Written documentation of these attempts, including reasonable financial consideration, must be included in any application for exception.

In the case of single residential dwelling construction where gravity fall to the street frontage cannot be obtained and the Applicant has been unable to acquire an easement for drainage through adjoining properties, alternatives which may be considered include:

a. minor regrading of the site to elevate the building platform to enable gravity drainage to the street frontage (subject to planning / building constraints on floor / roof height and impact on overland flow paths).

b. Roof or paved areas of less that 40m² being connected to a suitably designed rubble / absorption pit.

c. Installation of an on-site detention system connecting to a pit and pump system which incorporates twin pumps, and an emergency overflow system connection into a rubble /absorption pit system. The overall system is to be covered by a Restriction As To User on the property title covering maintenance.

For minor extensions (ie less than 40m²) to existing single residential buildings, connections may be made direct to the existing site drainage system where one exists.

A bond may be required to ensure the registration of any easements required, the value of which will be determined by Council's Director Operations.

Generally, where rubble /absorption pit systems are provided, trenches shall be 600mm wide x 600mm deep x 1000mm run per 15 sqm of area to be drained.

Where a pit and pump system is installed, Council requires the property owner to provide certification from an approved tradesperson/ engineer on an annual basis, indicating that the pit and pump system has been checked and is fully operational. Suitable wording shall be included in the Restriction As to User / Positive Covenant to define this requirement.

4.6 Relationship to Other Properties

Where surface runoff from adjoining properties flows onto the development / building site, such flows are to be catered for within the development. Obstructions that cause damming and backwater effects on upstream properties will not be permitted. Similarly, surface runoff from the site that is conveyed through the site is not to be concentrated onto downstream properties, or diverted from existing discharge points unless into Council's drainage system. Diverting flows from one catchment to another will not normally be permitted.

4.7 Stormwater Drainage Concept Plans (SDCP)

For developments that require a development application (DA), an SDCP is to be submitted with the application demonstrating the feasibility of the proposed drainage system within the site and connection to Council's system. This plan is also to show surface flow path treatment, extent of roof and paved areas, any easements required, On Site Detention storages as well as existing and proposed piped systems. The application will not be accepted without such a plan. Detailed design plans and calculations will be later required to be submitted with the Building Application for Council approval.

Where only a Building Application is required, full details and plans of the stormwater system including relevant calculations are required with the application. Building consent will not be issued until these details are submitted to and approved by Council.

Where easements are necessary over any adjoining or downstream property to achieve gravity drainage, a written agreement form the adjoining owners is to be submitted with the DCP.

4.8 Easements

For sites that have existing Council pipelines through them that are not covered by an easement, or where an existing pipeline is not within the easement, Council will require the

creation of an easement in favour of Council over the pipeline. The easement width is to be the pipe, box, or channel section width plus 1.5m, with an overall minimum width of 2.5m.

Site drainage systems will require inter-allotment easements over downstream properties where the drainage traverses any other private property to connect to Council's drainage system. Inter-allotment easements shall be 1.0m wide for pipe diameters up to 300mm.

Dual occupancies, where separate title is created over each unit, will require an inter-allotment drainage easement over the downstream lot in favour of the other lot for any drainage lines or structures affecting the former.

The process for obtaining easements is:

- Registered Surveyor to prepare plan of survey
- Plan to be submitted to Council for approval
- Plan and application to be lodged with owners approval at Land Titles
- Office and fees paid
- Council to be advised of lodgement details
- Land Titles Office advises applicant / owner and Council of registration.

4.9 Site Discharge and Connection to Council System

Site drainage is to connect to Council's system at the nearest suitable location.

Single residential developments will be permitted to connect pipe systems to the street gutter provided the discharge does not exceed 15l/s per outlet for the 100yr ARI design, with a maximum of two per nominal 20m street frontage. Dual occupancy developments may be permitted kerb connection where the total site discharge isles than 15l/s for the 100yr ARI design.

All other redevelopments / building works are required to connect directly to a Council pipe or channel system. The point of connection will be the closest suitable point as determined by Council's Director Operations. An access pit will be required at the point of connection, with one to be constructed if none exists.

Where the piped drainage system extends beyond the site to connect to Council's system, an access pit is to be provided at the boundary within the development site.

Where the connection point is not in front of the site the site drainage line is to be run to the kerb line and then to the nearest Council pit. A standard Council pit is to be constructed at the kerb in accordance with the Council drawing as shown in Supplement 5. The pipeline from the kerb pit to Council's pit is to be constructed under the kerb and gutter (or behind the kerb or in the road pavement if approved by Council's Director Operations). Any pavement or kerb and gutter disturbed is to be replaced. The pipes within the road or public lands are to be reinforced concrete with a minimum 375mm diameter. All costs for the connection are to be borne by the developer.

4.10 Studies / Analysis

In situations where flooding problems have occurred, or there is a risk of such occurrence, a flood study or drainage system analysis of the catchment containing the development / building site will be required. Where such a study is to be carried out, the calculation methods required to demonstrate satisfactory treatment of the development will generally be in accordance with current practice as outlined in Australian Rainfall and Runoff (1987), and subject to the satisfaction of Council's Director Operations.

4.11 Standards

Pipe systems draining the development site are to be designed to an ARI standard shown in the table below, with suitable treatment of all surface flows to a 100yr ARI standard. All relevant site pipe and surface flows to the 100yr ARI standard are to be routed through any OSD required.

Developments with higher potential damage risks from surface flows will require higher design standards. Where surface flow paths are not available, the pipe standard will rise to 100yr ARI.

Where the site or buildings are at or below the level of a downstream road or embankment, Probable Maximum Precipitation events are to be considered.

Piped Systems – ARI Standards

Residential	20 yrs
Commercial / Industrial	50 yrs
OSD Range	2 to 100 yrs

4.12 Safety and Consideration of Failure

Open drainage system components are to be designed to meet relevant safety criteria. Storage basins are to have battered slopes for egress, maximum ponding depths, and appropriate signage and fencing. Specific reference is made to Figure 6 Appendix B of the Floodplain Development Manual for velocity and depth limits, and to Supplement 2 for the design of OSD storages.

The possibility of failure of components of the system must be considered, and provision made for the safe conveyance of flows should failure occur. For OSD basins emergency spillways must be provided. The potential for obstructions to overland flow paths is to be minimised.

Underground storage should be designed to overflow and pond in a very visible part of the property so that the ponding will be noticed and the outlet blockage cleared before a major storm event.

4.13 Visual Impact

All drainage structures and measures are to be designed to be visually unobtrusive and sympathetic with the development / building. This requirement is necessary to ensure future occupants do not contemplate the adjustment or removal of facilities for aesthetic reasons without understanding the functional impact of such actions. In assessment of the design, Council will consider the affects on the landscape and the heritage aspects of the environment.

4.14 Runoff Quality (and Sediment) Control

Any stormwater runoff from the development / building work that has the potential for contamination by specific pollutants, will require treatment and be discharged in accordance with the requirements of the Environment Protection Authority (EPA). Referral for all other developments will be at the discretion of Council.

Sediment control measures will be required during the construction of all developments / building works, including all residential construction. Where the development has an ongoing risk of erosion, permanent measures will also be required. The measures are to be in accordance with the "Urban Erosion And Sediment control" Handbook, available from the NSW Department of Conservation and Land Management (CALM).

A plan of the proposed measures will be required with the application. Where off site disposal of excavated material will occur, a truck cleaning area will be required. The plan is to comply with the details given in section 5 of the CALM handbook. A summary of these is given in supplement 7.

Building plans / consent will not be released until the sediment control plan and details have been approved.

4.15 Restrictions As To User – Positive Covenants

The potential for modification or adjustment to OSD storages and / or surface flow paths through the property is significant enough to warrant extra protection. Future owners of properties also need to be aware of their presence and purpose. Consequently, a restriction As To User / Positive Covenant will be required on the property title as part of the development.

The restriction is created as a Positive Covenant using Form 55A for an Instrument Pursuant To Section 88E(3) of the Conveyancing Act, 1919 (see supplement 6). The Instrument is to ensure the continued functioning and maintenance of the items detailed in the consent condition.

A bond will be required against the creation of the restriction, the value of which will be determined by Council's Director Operations.

Positive Covenants for OSD will be required where the development includes:

- Single residential dwellings where OSD required
- Dual occupancy dwellings
- Medium and high density residential housing
- Commercial or industrial structures
- Tennis courts

Where a pit and pump system is installed, Council requires the property owner to provide certification from an approved tradesman/engineer on an annual basis, indicating that the pit and pump system has been checked and is fully operational. Suitable wording shall be included in the Restriction As To User / Positive Covenant to define this requirement.

Council will maintain a register of on-site detention systems and Council officers will inspect these systems on an annual basis to ensure such systems are maintained and are fully operational.

4.16 Structures Over or Near Drainage Lines and Easements

New buildings, structures and tennis courts will not be permitted over drainage lines or within easements. Paving over any drainage line or easement is acceptable, but will require appropriate jointing at the easement boundary, and to be in a material approved by Council's Director Operations.

Clearances to easement boundaries are required to prevent structural loads on drainage structures or encroachment within the angle of repose of the soil. Piering is an acceptable technique to achieve this.

If there is an existing structure over the drainage line or easement within the site that is part of the application, then an access pit is required to be provided upstream and downstream of the structure.

4.17 Natural Watercourses and Open Channels

The straightening, widening, lining, or piping of open channels will require the creation of inlet structures and surface flow paths to convey all flows to the 100 year ARI standard. Additionally, emergency flow paths are required in case of obstruction. Depending upon channel conditions on properties adjacent to the site, inlet training and outlet scour controls will be required.

Approval for enclosing or lining natural channels may be refused in areas where such work is not consistent with the character of the watercourse in the vicinity.

5 DESIGN REQUIREMENTS

5.1 Calculation Requirements

Calculations are to be prepared by an acceptable practitioner (see 7.2) and in accordance with current practices and principles outlined in “Australian Rainfall and Runoff” and other relevant sources.

Hydrologic calculations for internal systems can be prepared using a rational method basis. Hydraulic grade line calculations are required for any pipe systems where flows are in excess of 100l/s.

Where external catchment analysis is required, hydrologic calculations using time-area methods or a suitable equivalent are to be undertaken, with water surface profiles determined using grade line or backwater calculations as appropriate.

On-site Detention storage systems are to be sized and designed in accordance with Supplement 2. Where sites that require OSD cannot command the required site percentage coverage (see supplement 2), additional attenuation of flows through the storage and extra volume are required to compensate.

Areas likely to be paved after completion of the development at any point in the future based on the function of the development (eg driveways), will be determined as part of the impervious area and included as such in any calculations.

5.2 Tailwater Conditions and Downstream Controls

Water surface level calculations are to recognise the effect of any downstream controls, whether on the development site or external to the site. Where downstream water levels vary depending upon tide or channel flows, joint probability calculations are to be performed.

OSD systems must be designed such that under all conditions its outflow is not “outlet controlled”.

5.3 Freeboard

Freeboard for floor levels above top water level(TWL) of OSD storages is required for buildings near OSD storages, of at least 0.15m above the maximum spillway operating level for non-habitable areas, and of at least 0.30m above maximum spillway operating level for habitable areas.

A building floor level freeboard ranging from 0.3m to 0.5m will be required against channel or mainstream flows, or in areas where significant overland flow occurs. In all other circumstances a minimum freeboard of 0.15m is required above surrounding finished ground levels.

5.4 Structural Requirements

The design of any structures to be constructed as part of the drainage system excepting manufacturers pre-cast units such as pits, pipelines, and box culverts, are to be certified by a suitably experienced professional structural or civil engineer.

5.5 Practicalities, Physical Limits, Maintenance

OSD design is to provide for ease of inspection and regular minimum maintenance and be as tamper proof as possible. If located in landscaping areas, 50% additional volume will be required to allow for vegetation growth and saltation (design of the hydraulic controls is to be based on the normal volume).

Discharge control pits (DCP) are required to be fitted with screens. Screens need to be able to be easily removed for routine maintenance. The screen needs to:

a. protect the orifice from blockage,
b. to dissipate the kinetic energy of inflows creating static conditions around the discharge restriction which help to achieve predictable discharge co-efficents,
c. retain litter and debris which would degrade downstream waterways.

Screen Type
A small aperture-expanded steel mesh, such as Maximesh RH3030, is recommended for orifices less that 150mm in diameter. For orifices larger than 150mm, the screen area necessary for a fine mesh screen can make it difficult to fit in a DCP. A grid mesh, such as Weldlok F40/203, may be used for these larger orifices. Where the grid mesh is used, a fine mesh screen should be provided upstream of the DCP, for areas likely to collect debris.

Screen Area
The minimum area (including locked area) for an internal screen in a DCP is:

- 50 times the orifice area where a fine mesh is used,
- 20 times the orifice area where a grid mesh is used.

Screen Orientation
The inlet pipe to a DCP should direct inflows parallel to the screen. To assist in shedding debris the screen should be positioned as close as possible to vertical and in any case is to be placed no less than 45 degrees to the horizontal.

Pits are to be minimum of 0.6m by 0.9m, with the longer side parallel to the pipes. Step irons are required for pits over 1.2m deep. Pipe junctions are to be configured for minimum hydraulic losses. Pits are to be located wherever drainage lines bend greater than 5 degrees, enter pubic lands from private property, or connect to Council's system.

Standard details for kerb inlet pits are shown in Supplement 5. Access grates in road gutters are to be bicycle safe, with hinged grates. Where the pit is

located in a roadway (other than the gutter), pit lids are to withstand T44 traffic loadings and be of a lock down type.

Pipes within pubic lands are to be reinforced concrete, spigot and socket, rubber ring type. Alternative pipe materials and joints may be approved at the discretion of Council's Director Operations.

6 CONSTRUCTION AND DEVELOPMENT ACTIVITIES

6.1 Bonds

Where works are carried out on Council or pubic lands, (ie roads, parks etc) by or on behalf of the developer, a bond will be required to cover the cost of potential rectification works. The value of the bond will depend on the works proposed, and be determined by Council's Director Operations.

Bonds may also be required to cover the provision of OSD systems and the creation of easements and Positive Covenants. Any bonds required will need to be paid prior to the release of building approval.

6.2 Contractors Insurance and Road Opening Permits

Where works are carried out by parties other than Council on Council or pubic lands, the person or company carrying out the works will be required to carry pubic liability insurance, the minimum value of such coverage to be $5 million. Proof of the coverage will be required before works commence. Where such works are within a public roadway, a road opening permit is to be obtained before commencing works.

6.3 Inspections

Where works are to be carried out on a public roadway, or involve Council owned / operated structures, then advance notice and inspections will be required at specified stages during the works to ensure compliance with any requirements or conditions. The developer will be required t pay for inspections in accordance with Council's Fees and Charges.

The specified stages for inspections normally are:-

i. After the excavation of pipeline trenches.
ii. After the laying of all pipes, prior to backfilling.
iii. After the completion of all pits and connection points.

A minimum of one working day's notice shall be given to Council to obtain an inspection. Work is not to proceed until the works or activities covered by the inspection is approved.

6.4 Certification and Works-As-Executed (WAE) Plans

Certification and / or WAE plans will be required demonstrating that the site drainage system (including OSD components) together with any overland flowpaths have been provided according to the submitted calculations and / or approved plans. This may be waived when the precise construction of these is not critical to the functioning of the drainage system. Such certification will be either from an acceptable practitioner and /or a registered surveyor, as appropriate.

In some situations Council may require that certification should accompany the WAE plans, certifying that the drainage system as designed and constructed will have no adverse impact on drainage and surface flows through adjoining properties.

6.5 Traffic Control and Safety

Where works are undertaken on public roads, the applicant or contractor is to provide adequate traffic control and directions to motorists. Where such measures are not satisfactorily provided, Council may provide such and recover the costs from any bonds held. Traffic control is to be in accordance with Australian Standard 1742.3 – Traffic

Control Devices for Works On Roads, or any directions issued by Council's Director Operations during the works.

If driveway access to properties is to be disrupted, residents are to be advised in writing a minimum of 24 hours prior to the works. Access is to be restored outside normal working hours.

6.6 Connection to Council System

Where drainage works to connect to Council's system are to be carried out within public roads or lands, the applicant or any contractors performing the work are to ensure pubic safety at all times. The works are to be secured, signed and lit whenever the site is unattended.

If Council deems public safety to be at risk, it will provide all necessary measure to secure the site. The costs of such measures will be recovered from any security deposits or bonds held.

6.7 Restoration

Any disturbed areas within public roads or lands are to be restored to original or better condition, including landscaping. All restoration costs are to be borne by the developer.

Where other utilities or services require restoration as a result of works for the development, the restoration is to be to the relevant authorities requirements.

Where sections of kerb are to be replaced, including driveways, an integral kerb and gutter profile is to be used. Existing concrete structures are to be saw cut and contraction / expansion joints provided.

Road pavement restorations will be carried out by Council using the road restoration fees paid with the road opening permit, or using any bonds held. Where restoration works are carried out by approved contractors, inspections and compaction testing will be conducted to the requirements of Council's Director Operations.

6.8 Pipe Laying and Materials

All pipe laying and construction works are to comply with the requirements of any relevant Australian standards and codes, as well as the manufacturer's specifications. Occupational Health & Safety and Workcover legislation requirements are to be adhered to at all times.

For reinforced concrete (RC) and fibre reinforced cement (FRC) pipes, spigot and socket rubber ring joints are required. All other materials are to be to the manufacturers specifications for jointing. Where bolts or similar are required, stainless steel is to be used. PVC and HDPE pipes will not be permitted in load bearing situations.

All pits in pubic roads are to be constructed in reinforced concrete and kerb inlet pits in accordance with the detail in Supplement 5.

7. DOCUMENTATION REQUIRED

7.1 All Submissions

All applications are to include plans and calculations prepared by an acceptable practitioner which adequately demonstrate compliance with the policy and this Code.

7.2 Acceptable Practitioners

Any hydrologic, hydraulic or structural calculations submitted to Council are to be performed by a suitably qualified professional civil engineer. Similarly, any certification of works carried out that rely on these calculations are to be certified by an equally qualified person.

Registered surveyors may be recognised as suitable practitioners for drainage calculations at the discretion of Council's Director Operations, and subject to satisfactory demonstration of capability and experience.

7.3 Works-As-Executed Details (WAE)

Certification from a registered surveyor (or Civil Engineer) that all drainage works and structures have been constructed in accordance with the approved plans is to be provided to Council before permission to occupy is granted. Such certification is to include WAE plans. Any bonds held will not be released until all required certification has been received.

7.4 Details To Be Submitted With Applications

A Stormwater Drainage Concept Plan (SDCP) is to be submitted with any Development Application, outlining the treatment and disposal of all stormwater from the site (See 4.7). This plan is to demonstrate that the methods proposed are feasible and comply with the Code.

Design plans and calculations are to be submitted with building applications to demonstrate all measures and structures will function as claimed and comply with relevant codes and/or practice. This should also include survey information about structures, all impervious areas proposed and existing, surface flow paths, and ground levels extending at least 5m beyond the property boundaries. The latter is particularly important where re-contouring of the site is proposed or the development has the potential to affect other properties.

Plans of the layout and dimensions of all drainage structures and treatments are required. Any Benchmark used to determine levels is to be shown, with levels to AHD wherever a PM or SSM is available within 250m.

8 OTHER AUTHORITIES

8.1 Water Board

Applications may be referred to the Board where it is responsible for any channel being connected to downstream of the development. Any requirements of the Board will need to be met before approval can be granted.

8.2 Services

Wherever any public utility service is affected by the development. It is the responsibility of the developer to determine the location of the service and to ensure the development complies with the requirements of the relevant authority. Any costs associated with such are to be borne by the developer.

8.3 Environment Protection Authority (EPA)

All stormwater runoff must ultimately comply with the Clean Waters Act 1970 and Clean Waters Regulations 1972, which are administered by the Environment Protection Authority (EPA) of NSW. It is the responsibility of the developer to ensure any EPA requirements are met.

Certain developments, such as petrol stations, will require written confirmation that appropriate approvals and licences have been obtained prior to the release of building plans.

9 INFORMATION AVAILABLE FROM COUNCIL

9.1 Drainage System Information

Council will make available information on its drainage system where it is available, on the express understanding that Council is not liable for the accuracy of the information or the consequences of it being used. Results from drainage studies carried out for Council, which have been reported to the Council, may also be made available.

Information provided to Council by other parties may be released at the discretion of Council's Director Operations, subject to copyright and privacy restrictions, and on the understanding Council makes no guarantees as to its validity.

9.2 Location and Details of Pipelines

The developer and/or design consultants will need to confirm, by inspection add /or survey, any information affecting designs. This includes confirmation of pit locations, pipe locations and size, and utility authority service locations.

9.3 Codes and Policies

Any Council document or policy referred to in this Code will be available to the public. A fee will be charged for the document to cover production costs, and will be set in Council's annual fees and charges.

10 GLOSSARY

Australian Rainfall & Runoff (AR&R)

A technical publication fro the Institution of Engineers Australia providing guidance on current drainage design practice.

Average Recurrence Interval (ARI)

A statistical likelihood of a storm event of at least a designated average rainfall intensity occurring. The probability is a long term average, and not a period between events (eg 10 years ARI indicates 10 randomly spaced events over 100 years).

Hydrology & Hydraulic

Hydrology is the estimation of the runoff and flow rates of rainfall once on the ground. The term hydraulic refers to calculating the capacity or characteristics of flow control devices and conduits (pipes)

On-site Stormwater Detention (OSD) Storage

Restricting the outflow of stormwater runoff from a site by draining collected surface flows from paved and roof areas through a storage with an outflow control device.

Probable Maximum Precipitation (PMP)

An estimate of the maximum amount of rainfall that could possible occur.

Stormwater Drainage Concept Plan (SDCP)

A site plan of a development showing buildings and proposed drainage measures and structures. This should include existing and proposed ground and floor levels, as well approximate sizes of drainage structures and surface flow path treatments. Preliminary hydrologic calculations should accompany the plan.

10 REFERENCE

"Australian Rainfall & Runoff", (AR&R) 1987, Institution of Engineers, Australia.

"Surface Water Management On The Covered Forecourt Areas Of Service Stations", Environmental Protection Authority, 1992

"Urban Erosion & Sediment Control", NSW Department of Conservation and Land Management, Draft 1992.

"Floodplain Development Manual", December 1986, Department of Planning, NSW Government.

"The Estimation of Probable Maximum Precipitation in Australia for Short Durations and Small Areas", Bulletin 51, August 1984, Bureau of Meteorology, Department of Science & Technology.

"Storm Drainage Design in Small Urban Catchments", 1986, ARRB Special Report No.34, John Argue.

"Model Analysis to Determine Hydraulic Capacities of Kerb Inlet and Gully Pit Gratings.", 1979, Department of Main Roads NSW

'Pressure Changes at Storm Drain Junctions", Engineering Services Bulletin 41, 1958, University of Missouri, Sangster et al.

"Magnitude of Head Losses at Junctions in Piped Drainage Systems", 1983, Civil Engineering Transactions, C Hare.

12 SUPPLEMENTS

1. Intensity Frequency Duration (IFD) Rainfall Data
2. On Site Stormwater Detention (OSD) requirements
3. Requirements For Hydrologic Calculations & Modelling
4. Hydraulic Design & Details
5. Grated Road Stormwater Pit with Extended Kerb Inlet
6. Wordings for Restrictions As To User & Easements
7. Sediment Control Plans
8. Applicant Checklist

SUPPLEMENT 1

Intensity Frequency Duration (IFD) Rainfall Data

2 year	**1_1 hr: 36.04**	**50 year**	**1_1hr: 71.06**
	1_{12}hr: 7.42		**1_{12}hr: 15.51**
	1_{72}hr: 2.42		**1_{72}hr: 4.96**

Co-efficient **G: 0.00**
F_2: 4.29
F_{50}:15.80 **Values are in mm/hour**

AVERAGE RECURRENCE INTERVAL (ARI) YEARS

TIME	1	2	5	10	20	50	100
5 mins	90.0	115.2	145.9	163.3	186.7	217.0	239.9
6 mins	84.4	108.0	136.9	153.4	175.4	204.0	225.6
7 mins	79.7	102.0	129.5	145.1	166.0	193.1	213.6
8 mins	75.7	96.9	123.1	138.0	157.9	183.8	203.4
9 mins	72.2	92.5	117.5	131.8	150.9	175.7	194.5
10 mins	69.1	88.6	112.6	126.4	144.7	168.6	186.6
12 mins	63.9	82.0	104.4	117.2	134.2	156.4	173.2
14 mins	59.6	76.5	97.6	109.6	125.6	146.5	162.3
15 mins	57.8	74.2	94.6	106.3	121.9	142.1	157.5
16 mins	56.1	72.0	91.8	103.2	118.4	138.1	153.1
18 mins	53.0	68.1	87.0	97.8	112.2	130.9	145.1
20 mins	50.4	64.7	82.7	93.1	106.8	124.7	138.3
25 mins	45.1	57.9	74.2	83.5	95.9	112.1	124.3
30 mins	41.0	52.7	67.6	76.2	87.6	102.4	113.6
40 mins	35.1	45.2	58.1	65.6	75.4	88.3	98.1
50 mins	31.0	39.9	51.5	58.1	66.9	78.4	87.2
1 hour	28.0	36.0	46.5	52.6	60.6	71.1	79.0
1.5 hours	21.7	28.0	36.3	41.1	47.5	55.8	62.1
2 hours	18.1	23.4	30.4	34.4	39.8	46.8	52.2
3 hours	13.9	18.0	23.5	26.7	30.9	36.5	40.7
4.5 hours	10.7	13.9	18.2	20.7	24.0	28.4	31.7
6 hours	8.9	11.6	15.2	17.3	20.1	23.8	26.6
9 hours	6.9	8.9	11.8	13.4	15.6	18.5	20.7
12 hours	5.7	7.4	9.8	11.2	13.1	15.5	17.4
15 hours	5.0	6.5	8.6	9.8	11.4	13.6	15.2
18 hours	4.5	5.8	7.7	8.8	10.3	12.2	13.6
24 hours	3.8	4.9	6.5	7.4	8.6	10.2	11.5
30 hours	3.3	4.3	5.7	6.5	7.5	8.9	10.0
36 hours	3.0	3.8	5.1	5.8	6.7	7.9	8.9
48 hours	2.5	3.2	4.2	4.8	5.6	6.6	7.4
72 hours	1.9	2.4	3.2	3.6	4.2	5.0	5.5

SUPPLEMENT 2

On Site Stormwater Detention (OSD) Storage Requirements

S2.1 Design Values

The OSD storage is to be designed to the storage / discharge relationship appropriate to the development type.

The values are given per 1000m^2 of the ***total development site***. All paved and drained impervious surfaces are to drain to the OSD storage.

	Group	Storage (m^3) *	Permitted Discharge from Storage (l/s)*
Residential (except Single Dwellings **)	1	6	13
		9	17
Based on 70% impervious		15	23
Commercial / Industrial – Small	2	7	20
Based on 95% impervious		11	25
		18	33
Commercial / Industrial – Large	3	12	12
Based on 95% impervious		21	16
		32	23

NOTES

***** The three pairs of values respectively represent 2, 10 and 100 year ARI values.

** Refer Section 4.2. for limits to applicability.

S2.2 Other Design Requirements

***** The outflow control structure is to be designed to control variable outflow rate in accordance with the storage-discharge relationship fro S2.1.

* All roof and paved areas are to drain through the storage.

* Storages are to be located separate from any external surface flow paths. Where additional paved areas form part of a designated surface flowpath and therefore cannot be drained to the OSD system, an equivalent area within the site is to be commanded by the OSD system.

* Finished ground levels are to be constructed so that impervious area runoff, in excess of the pipe system capacity, drains to the storages.

* The maximum storage level is to be such that habitable floor levels are at least 0.3m above the maximum water level, and garages 0.15m above.

* An emergency overflow with flowpath is to be provided and is to be free of obstructions such as fences.

* Maximum ponding depths for above ground storages are to be 0.15m in parking areas, 0.3m in landscaping, and 1m in a fenced off area. Where the storage is located in an area where frequent ponding could cause maintenance problems or personal inconvenience to property owners, the first 10% - 20% of the storage is to be provided in an area able to tolerate frequent inundation.

* Storage volumes in landscaping areas are to be increased by 50% to allow for vegetation growth.

* Surface storage areas in strata or community title developments are not to be in privately controlled areas such as courtyards.

* Hydraulic control devices are to be constructed to be non removable.

* Existing stormwater storages can be incorporated into the new design.

* Minimum diameter of restriction is to be 75mm.

S2.3 Worked Example – Hydraulic Controls

Example 1:

Development Type: Dual Occupancy
Site area determined from title: 1200m²

Storage/Discharge – Group 1 values per 1000m² of site area

ARI (y)	Storage (m3)	Permitted Discharge (l/s)
2	6	13
10	9	17
100	15	23

Separate storage required for each lot if separate (ie community) titles apply.

Say Lot 1 = 700m² and Lot 2 = 500m²

Therefore, proportion areas and discharges between lots

	Basin 1		**Basin 2**	
ARI (y)	Storage (m3)	Permitted Discharge (l/s)	Storage (m3)	Permitted Discharge (l/s)
2	4.2	9.1	3	6.5
10	6.3	11.9	4.5	8.5
100	10.5	16.1	7.5	11.5

Basin 1

Assume maximum above ground storage is 300mm deep and outlet pit depth is 400mm (to centreline of outlet pipe).

Calculate outlet pipe diameter in 100 year event (when permitted discharge is 16.1 L/s).

Diameter, $d = (0.48 \times Q / h^{0.5})^{0.5}$

$= (0.48 \times 0.0161 / 0.7^{0.5})^{0.5} = 0.096m$ (or 96mm)

Test performance in 2 year event.

Assume negligible storage in pit and that volume above ground increases linearly with depth.

Therefore storage depth in 2 year event
= 4.2 / 10.5 x 300 = 120mm

Therefore head over centreline of pipe equals 120 + 400 = 520mm

Therefore outflow, Q = CA $(2gh)^{0.5}$ (where A is the area of the restriction
= 0.6 x 0.0072 x $(2 \times 9.81 \times 0.52)^{0.5}$
= 0.0136m^3/s (or 13.6L/s)

This flow is larger than permitted discharge if 9.1 L/s. Therefore system trial is not satisfactory.

To reduce the hydraulic head in the 2 year event it is necessary to store a significant amount of water in the outlet pit. If outlet pipe diameter is 96mm, then using orifice equation the limiting head is 0.23m (230mm) to achieve a flow of 9.1L/s.

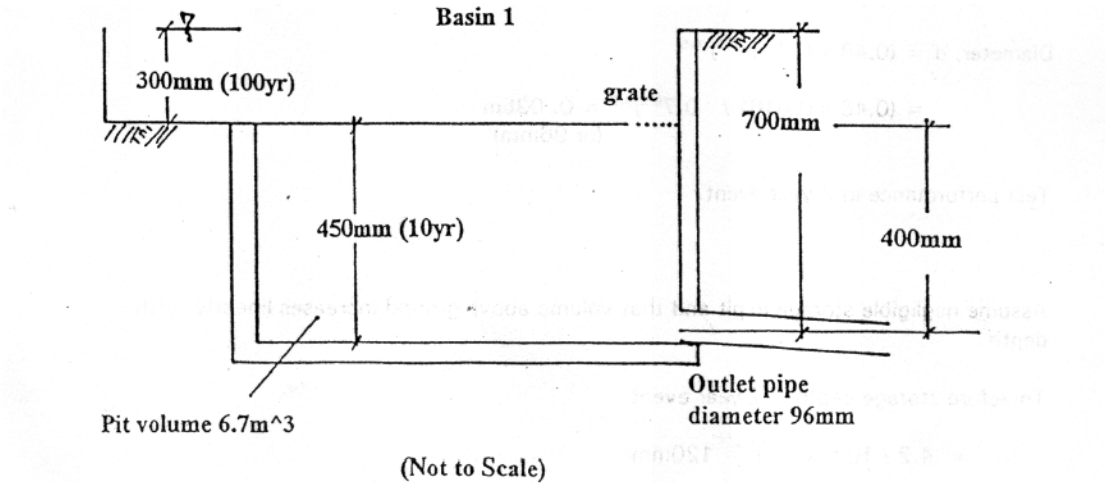
Hence pit storage capacity for depth of 280mm (that is, limiting head plus outlet pipe radius) corresponds to 4.2m^3 (for 2 year event).

If pit total depth equals 450mm (that is, depth to outlet pipe centreline plus pipe radius) then pit storage to grate level equals 450 / 280 x 4.2m3 = 6.7m^3

Check 10 year event performance:

When pit is just full then 10 year event storage is satisfied. Using orifice equation check the pipe outflow:
Q = CA (2gh)0.5
= 0.6 x 0.0072 x (2 x 981 x 0.4) 0.5
= 0.0119m^3/s (or 11.9 L/s)

This satisfies the permitted discharge in the 10 year event.



Basin 2

Assume maximum above ground storage is 150mm deep and pit depth is 200mm to centreline of outlet pipe.

Assume pit storage capacity is negligible and hence (above ground) storage increases linearly with depth.

Therefore storage depth for a 2 year event is 3 / 7.5 x 150 = 60mm

Head over outlet pipe = 60 + 200 = 260mm

Using orifice equation
Diameter, d = $(0.48 \times Q / h^{0.5})^{0.5}$
= $(0.48 \times 0.0065 / 0.26^{0.5})^{0.5}$
= 0.0752 m (or 75mm)
Utilise a weir to cater for additional flow in a 100 year event.

Outflow in 100 year event through outlet pipe is

$Q = CA (2gh)^{0.5}$ (where h = 0.35m)
$Q = 0.6 \times 0.0041 \times (2 \times 9.81 \times 0.35)^{0.5}$
$= 0.0064 \ m^3/s$ (or 6.4l/s)

Weir capacity = permitted discharge – pipe outflow
= 11.5 L/s-6.4L/s
= 5.1L/s

Head over weir equals difference in water levels in 2 year and 100 year events,
that is head = 350mm – 260mm
= 90mm

using weir equation, $Q = CLH^{1.5}$ (C = 1.6)
$L = Q/(1.6 \times H^{1.5})$
$= 0.0052 / 1.6 \times 0.09^{1.5})$
= 0.12m
= 120mm

Check 10 year event performance:

Depth of water above ground

= 4.5 / 7.5 x 150 = 90mm

Calculate combination of outlet pipe flow and weir flow for 10 year event:

Head over pipe = 290mm (being 200 + 90)

Pipeflow, $Q = CA (2gh)^{0.5}$
$= 0.6 \times 0.0041 \times (2 \times 9.81 \times 0.29)^{0.5}$
= 0.0059 m/s
(or 5.9 L/s)

Weir flow, $Q = CLH^{1.5}$
$= 1.6 \times 0.12 \times (0.03)^{1.5}$
= 0.001m/s
(or 1L/s)

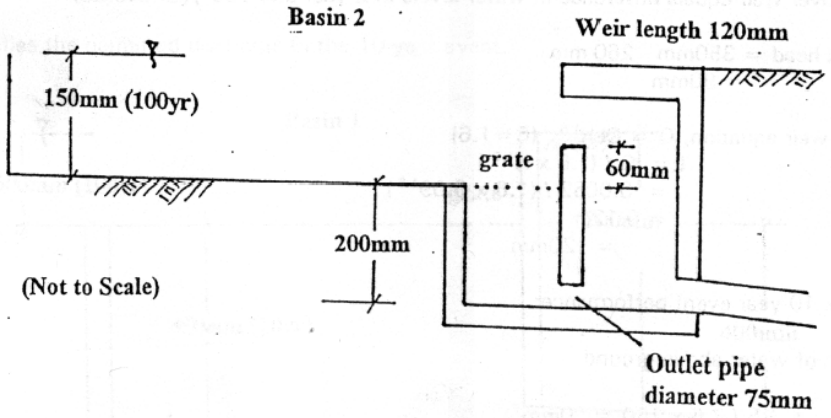
Therefore the combined flows are:

= 5.9 + 1.0
= 6.9L/s

This is just below the permitted discharge of 8.5L/s in the 10 year event.

Note 1: For Basin 2 there is a combination of outlet pipe plus weir outflow. Flows from both controls need to be combined and piped to Council's drainage system (kerb side or pipe). To avoid adverse impact on the reduced diameter outlet pipe it is appropriate that the water level in the downstream pit does not impact on that outlet pipe. This may require a drop pit at that location.

Note 2: Basins 1 & 2 have slightly odd pipe diameters in their solutions. In practice the range of storage depths etc are governed by utilising commercially available standard pipe diameters.



Example 2

Development Type Medium Density
Site area determined from title: 2500m²

Storage / Discharge – Group 1 values per 1000m² of site area

ARI (Yr)	Storage (m^3)	Permitted Discharge (L/s)
2	6	13
10	9	17
100	15	23

Single storage proposed. Therefore storage and discharge values are as follows:

ARI (Yr)	Storage (m^3)	Permitted Discharge (L/s)
2	15	32.5
10	22.5	42.5
100	37.5	57.5

Storage proposed in landscaped /lawn area. Maximum above ground storage depth is one metre, with area having an inverted conical shape.

Using conical volume equation (1/3 x base area x height)
calculate depth to satisfy volume for 2 year event, ie.$15m^{3.}$

Hence depth (over pit grate) = 0.75m

Determine pipe diameter in bottom pit:

Head over pipe centreline equals ponding depth plus pit depth = 0.75 + 0.40 = 1.15m

Limiting 2 year permitted discharge = 32.5L/s

Diameter, $d = (0.48 \times Q / h^{0.5})^{0.5}$
$= (0.48 \times 0.0325 / 1.15^{0.5})^{0.5}$
= 0.120m (or 120mm)

To cater for increasing outflows for 10 year and 100 year events set weir structure in the bank where lip level of weir is set at water level for 2 year event.

In 100 year event, the weir capacity needs to equal the difference between the permitted discharge (5.7L/s) and outflow through the pipe outlet.

Calculate flow through pipe outlet where head equals 1.0 + 0.4 = 1.4m in 100 year event, since the maximum depth of storage in a fenced landscape area is 1.0m.

Using orifice equation $Q = CA(2gh)^{0.5}$
$= 0.6 \times 0.0113 \times (2 \times 9.81 \times 1.4)^{0.5}$
$= 0.0355\ m^3/s$ (or 35.5L/s)

Therefore weir flow = 57.5 – 35.5 = 22.0L/s

For a head of 0.25m (difference between water levels in 100 year an d2 year event),
Calculate weir length.

Weir equation $Q = CLH^{1.5}$ (C = 1.6)

Therefore L = $Q / CH^{1.5}$
= $0.022 / 1.6 \times (0.25)^{1.5} = 0.11m$ or 110mm

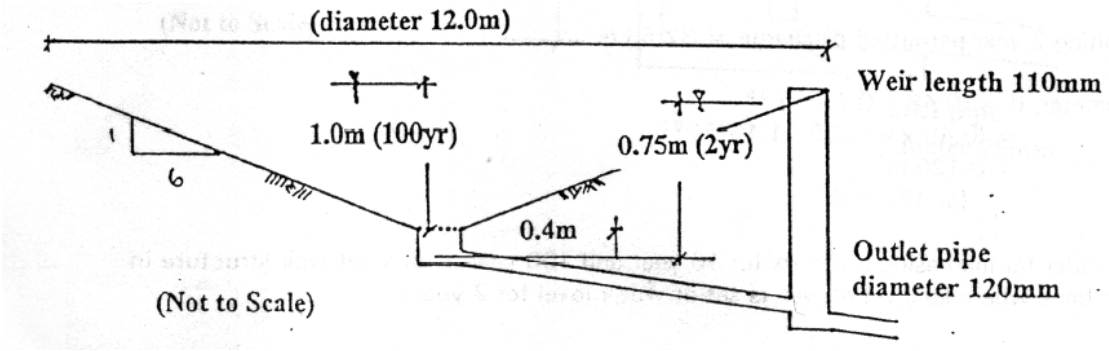
Check mid range performance (in 10 year event)

In 10 year event the depth of water above pit grate is 0.85m to satisfy 10 year storage requirement of 22.5m3. Therefore flow in 10 year event is a combination of pipe plus weir outflow.

Pipe flow, Q = $CA(2gh)^{0.5}$ where h equals 0.85 + 0.40m = 1.25m
Therefore Q = $0.0336m^3/s$ (or 33.6L/s)

Weir flow, Q = $CLH^{1.5}$
= $1.6 \times 0.11 \times (0.1)^{1.5}$
= $0.0055m^3/s$ (or 5.5L/s)

Therefore Total Flow = 33.6 + 5.5
= 39.1 L/s which is just less than the permitted flow of 42.5 L/s.



Example 3

Development Type Commercial
Site area determined from title 4000m^2

Under pre-development conditions the site's time of concentration equates to a "large" commercial / industrial site. Therefore Group 3 requirements apply.

Storage /Discharge – Group 3 values per 1000m^2 of site area

ARI (Yr)	Storage (m^3)	Permitted Discharge (L/s)
2	12	12
10	21	16
100	32	23

Single storage proposed. Therefore storage and discharge values are as follows:

ARI (Yr)	Storage (m^3)	Permitted Discharge (L/s)
2	48	48
10	84	64
100	128	92

Assume storage is provided by way of single underground tank (since above ground storage is usually not feasible for a commercial development).

Say maximum water depth is 1.5m, therefore to achieve 100 year storage of 128m^3 in a square tank means tank wall length is 9.3m.

Volume increases linearly with depth therefore depth in 2 year event equals
V = 48 / 128 x 1.5 = 0.56m

Determine corresponding pipe diameter for controlling 2 year event discharge:

Orifice equation, $Q = CA(2gh)^{0.5}$ (where C = 0.60)
Transposing terms yields

Diameter $d = (0.48\ Q / h^{0.5})^{0.5}$
$= (0.48 \times 0.048 / 0.56^{0.5})^{0.5}$
= 0.175m (175mm)

Check outlet performance for 10 year event:

Depth in 10 year event equals 84 / 128 x 1.5 = 0.98m

For h = 0.98m, $Q = CA(2gh)^{0.5}$
$= 0.6 \times 0.024\ (2 \times 9.81 \times 0.98)^{0.5}$
= 0.063m^3/s (or 63L/s)

This flow equals the 10 year limiting flow.

Check outlet performance for 100 year event:

Depth in 100 year event equals 1.5m

For h = 1.5m Q = $CA(2gh)^{0.5}$
= $0.6 \times 0.024 (2 \times 9.81 \times 1.5)^{0.5}$
= $0.078\ m^3/s$ (or 78L/s)

This flow is significantly less than limiting flow, of 92L/s. Under such a scenario, additional storage would be required or alternatively install a second outlet pipe at top water level for 10 year event. The latter approach is the preferred (and cost effective) approach.

Depth difference between water levels in 10 year and 100 year events is

D = 1.5 – 0.98 = 0.52m

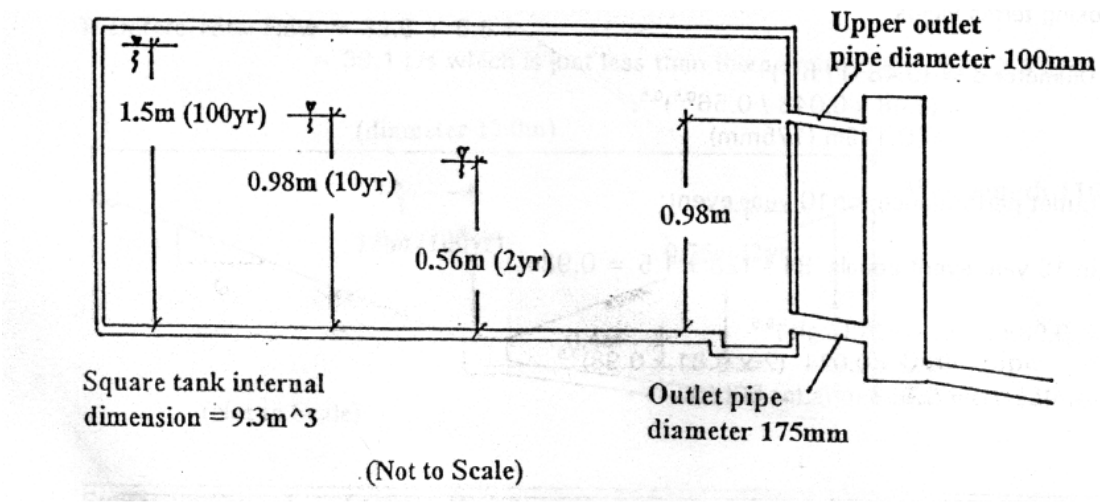
With higher level pipe invert set at 10 year top water level than head over centerline of new pipe is approximately 0.45m.

Flow to be conveyed by higher level pipe equals difference between 100 year permitted discharge and 100 year outflow through bottom pipe outlet – that is,
92L/s – 78 L/s = 14 L/s

Calculate diameter for higher level pipe:

Diameter, d = $(0.48\ Q / h^{0.5})^{0.5}$
= $(0.48 \times 0.014 / 0.45^{0.5})^{0.5}$
= 0.100m (or 100mm)

Note: This solution has pipe diameters of 175mm and 100mm. A 175mm dia pipe is not a standard size therefore tank dimensions are more usually governed by the range of commercial pipe diameters.



S2.4 Basis For Determining Catchment Based Design Values - STRATHFIELD

The design values for the above table were determined from studies of two catchments undertaken by Bewsher Consulting on behalf of Council. The catchments were C4 Rochester Street and C9 Augusta Street, draining to the Parramatta and Cooks River basins respectively. The shape, size and characteristics are typically representative of all of the catchments within the Strathfield area.

The study used generic developments located at various points within the catchments. The storage requirements were set to ensure no increase in runoff after development anywhere within the catchment.

The results indicated the values were not greatly sensitive to initial pervious area or site location within the catchment. The adopted design requirements are intended to provide the simplest design criteria that meets the no increase in runoff requirements.

Assumed values of potential impervious area for development types have been used to cover future impervious site coverage not controlled by application to Council eg. paving. The values are the maximum permitted by Council policy or code for the development type.

SUPPLEMENT 3

Requirements For Hydrologic Calculations & Modelling

3.1 Rational Method Calculations

Rational method calculations are generally acceptable to determine stormwater runoff quantities to design piped drainage systems. However, where multiple storages are proposed then a time based model is required to account for variable timing of storage outflow peaks. Also, if a pipe system requires a capacity greater than 250 l/s or the development site area exceeds 0.5 Ha, a model is required to design the system.

The Rational Method formula is Q – C.I.A.K, where

Q	=	discharge
I	=	Intensity for Tc
Tc	=	Time of overland flow concentration
A	=	Area
K	=	constant dependant upon units used

Intensity is determined using Supplement 3

Tc can be calculated using the kinematic wave formula from AR&R pp300.

Note L = is pre existing flow path that is modified by the development by piping, paving or redirecting.
n is per AR&R pp300 with minimum of 0.25 for non paved areas
A = area of catchment affected not just the development site.

3.2 Modelling Drainage Systems & Flooding

The preferred model for urban pipe systems is ILSAX. Other acceptable models are RORB, RAFTS, EXTRAN, THSM, MIKE11-UD,MOUSE.

Council may not have the models referred to or expertise in their use, excepting ILSAX. Calculations based on these models may cause delays in checking. Also full model details, data and calculation results will be required.

Parameters for the preferred model:

* Soil = 3
* AMC = 3
* Infiltration Initial Paved = 1
  Grassed = 5mm

* Storms. As per AR&R 1987.
  25min & 2 hr are the expected worst case due to temporal patterns. Other storm durations should be checked to confirm the worst case adopted.

* Time of Entry (Te) uses the Kinematic Wave formula – see rational method calculations for details.

* No stored bypass or surcharge. Either redirect or determine storage behaviour.

SUPPLEMENT 4

Hydraulic Designs & Details

Pit Inlet Capacities Design Values

For standard grated inlet pits with an extended kerb inlet as detailed in Supplement 8, the inlet capacities are (using the for y = mx+b) :

Inlet Length	Im	2m	3m
Constant – b (l/s)	25	35	4
Rate – m	0.42	0.55	0.75

Sag pits formulae for grates and kerb inlet openings are available on page 303 or AR&R. Note these values make no provision for blockage or surcharged pits. On grade pit capacities are based on work by Bowditch (1973), Department of Main Roads NSW (1979) and Armstrong (1979).

Hydraulic Grade Line (HGL)

HGL calculations are required where pipe flows exceed 100 l/s, the drainage system crosses properties external to the development, or where the Manager Engineering determines that the connection to Council's system warrants such calculations.

Pit Losses

* Use Missouri charts (Sangster et al), Hare charts or relevant derivations of these.

* Ensure the pit loss factor (K) used matches the pit design. The pit configuration should ensure the projection of the incoming pipe is within the outgoing conduit on the downstream pit face. *(NB this generally requires rectangular pits to be built parallel / square to the upstream line, with the downstream pipe cut at an angle where it joins the pit. This is the opposite of typical construction patterns. Therefore the worst case assumption will be used by council in checking K factors unless construction plans have pit layout diagrams.)*

* Drop pits are not permitted as there is no acceptable determination of loss factors, as well as empirical results indicating drop pits behave as surcharge point with less than the nominal system capacity. Invert matching is recommended in preference to obverts.

* Use Colebrook White roughness values

* Use the surface level as the downstream HGL for connections to existing pit.

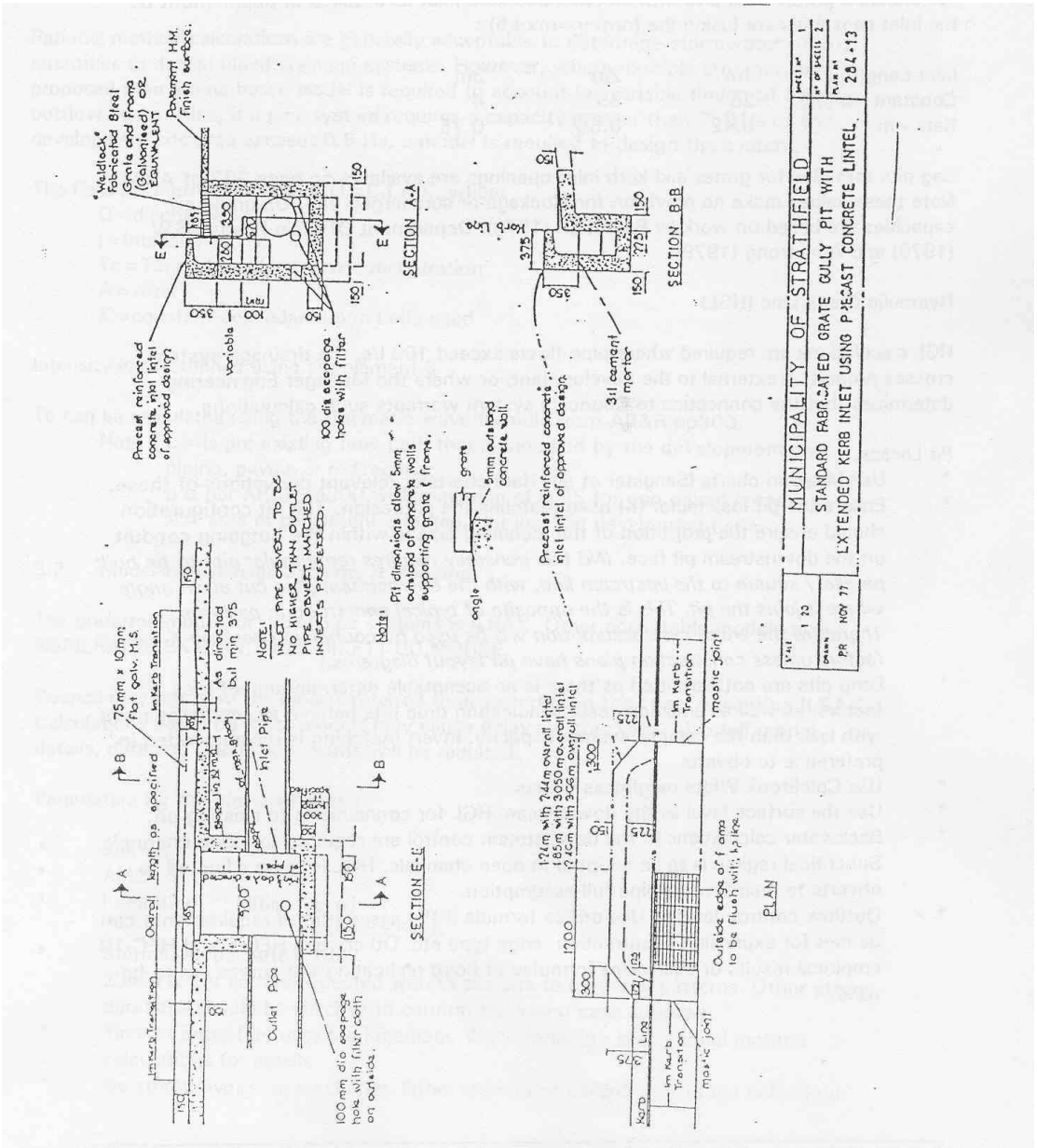
* Backwater calculations to the downstream control are required for open channels. Subcritical regime is to be adopted in open channels. HGL is to be adjusted to obverts to maintain the pipe full assumption.

* Outflow control devices. Use orifice formula if the assumption / requirements can be met for expansion / contraction, edge type etc. Otherwise, HEC-5 and HEC-10 empirical results or equivalent formulae of Boyd replicating the curves are to be used.

SUPPLEMENT 5

Standard Drawing & Details

Grated Road Stormwater Pit With Extended Kerb Inlet



SUPPLEMENT 6

Wording For Restriction As To User & Easements

Restriction As To User – Positive Covenant Form 55A
Instrument Pursuant To Section 88E(3), Conveyancing Act, 1919

On Site Detention

"The stormwater detention facility as described by the plan …. of Strathfield Council Building Consent …. and the conditions of such consent, shall not be altered or removed in whole or in part without written approval of Strathfield Council.

The registered proprietor is to maintain the stormwater detention facility in working condition.

The pit and pump drainage system shall be inspected annually by an approved tradesperson / Engineer. The approved tradesperson / Engineer shall certify to Council annually that the system has been checked and is fully operational.

Authorised Strathfield Council employees are to be allowed access for inspection upon reasonable notice. The registered proprietor is to comply with any notices issued by Council regarding rectification or maintenance works to be carried out for compliance.

In the event of the registered proprietor not complying with the notice, Council or its authorised agents may enter and carry out the specified work, and recover the costs due."

Stormwater Surface Flow Path

"The stormwater surface flow path defined … shall not be obstructed or have the *{finished ground (and/or) pavement levels}* within the defined area modified in whole or in part without written approval of Strathfield Council. It shall be the responsibility of the registered proprietor to ensure the stormwater surface flow path is kept unobstructed by fences or any physical structures or barriers (whether temporary or not) at all times.

Authorised Strathfield Council employees are to be allowed access for inspection upon reasonable notice. The registered proprietor is to comply with any notices issued by Council regarding rectification or maintenance works to be carried out for compliance.

In the event of the registered proprietor not complying with the notice, Council or its authorised agents may enter and carry out the specified work, and recover the costs due."

SUPPLEMENT 7

Sediment Control Plans

Preparation of the Plan

The following is a brief summary of the details involved in preparing a control plan taken from chapter 5 of the "Urban Erosion and Sediment Control" handbook by the Department of Conservation and Land Management. The handbook should be referred to in the preparation of the plan.

The points under each item give the details required to be submitted as part of the control plan. Some details listed wil already be provided to meet other requirements.

1 Investigate site characteristics ie. Topography, soils, vegetation. The plan should include:

- Locality plan
- Plan of site and surrounding area with contours and catchment boundaries.
- Soil and vegetation types and coverage
- Any other relevant features

2 Integrate clearing and grading with site layout plan, including consideration of staging of works. The plan should include areas to be exposed and the type and extent of the earthworks.

3 Determine existing and proposed drainage patterns, including diversion of flows entering the property from upstream, and impact of development on flow paths. Much of this information should be detailed as part of the stormwater design.

4 Select erosion control practices. Details of the proposed measures should include:

- Location and design criteria of structural and vegetation erosion control measures needed to control the volume, direction and velocity of runoff.
- Scheduling of construction / implementation of the measures.
- Maintenance of the measures

5 Outline the rehabilitation program, including:

- Areas where temporary and permanent revegetation is to be employed
- Details of stabilising of exposed soils
- Types of planting materials or ground coverings

SUPPLEMENT 8

Applicant Checklist

	Single Residential	Dual Occupancy	Villa, Flats, Town Houses etc	Commercial Industrial Institutional	Tennis Courts	Drainage Works Only	Paving
On Site Detention	No (2)	Yes	Yes	Yes	Yes	No	***(1)
Gravity Pipe System Required	Yes (3)	Yes	Yes	Yes	Yes	Yes	Yes
Pumps System Permitted	No (3)	No	No	No	No	No	No
Drainage Easement over downstream property	If site does not drain to street	If site does not drain to street	If site does not drain to street	If site does not drain to street	If site does not drain to street	***(1)	***(1)
Connection to kerb permitted when no Council pipeline nearby	***(1)	Maximum flow must be less than 15 l/s	No	No	***(1)	No	***(1)
Security Bonds Required	***(1)	Yes	Yes	Yes	Yes	Yes	***(1)
Qualified Engineer Required to prepare drainage design	Yes	Yes	Yes	Yes	Yes	Yes	***(1)
Sediment Control Plan Required	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Restriction As To User Required. (ie 88E Instrument)	No (2)	Yes	Yes	Yes	Yes	No	No

1 Depends on details of development

2 Except for cases where increased roof and paved areas exceed 40m² and gravity drainage / easements are not possible or where site imperviousness exceeds 65% of site area.

3 Except where genuine attempts to acquire an easement at reasonable costs have failed. Documentary evidence of these attempts will be required